# PATENT SPECIFICATION

*Inventor*: MAURICE SAXON SNELL.

715,226

*Date of filing Complete Specification April 7, 1953.*

*Application Date April 7, 1952.* No. 8857/52.

*Complete Specification Published Sept. 8, 1954.*

Index at acceptance :—Class 35, A(5B : 7B : 8B), G2E.

COMPLETE SPECIFICATION

## Improvements relating to Electro-Magnetic Coils

We, DOWTY EQUIPMENT LIMITED, a British Company, of Arle Court, Cheltenham, in the County of Gloucester, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to coils for electro-magnetic devices and its object is to provide a construction of less weight than hitherto, and improved heat dissipating properties.

According to the invention, an electro-magnet coil comprises a number of flat spiral windings of uniform aluminium strip mounted side by side on a former with layers of insulating material between them, the consecutive turns of each winding lying directly one upon the other and being electrically insulated from each other by an oxidised surface layer formed on one or both sides of the strip, and electrical junctions formed between the terminations of adjacent windings to provide a series connection of said windings from end to end of the coil.

The invention is illustrated in the accompanying diagrammatic drawings, of which:—

Figure 1 is a perspective view of a flat spiral winding of aluminium strip;

Figure 2 is a central sectional view of an electro-magnet incorporating several such windings of aluminium strip; and

Figures 3, 4 and 5 are detail views showing successive stages in the formation of electrical junctions between the terminations of adjacent windings.

Figure 1 shows a flat spiral winding 6 of aluminium strip which is electrically insulated, preferably on both sides, by the formation thereon of thin oxidised coatings. Conveniently, the oxidised coating is formed by electrolytic treatment in a bath through which the strip is drawn continuously, and a thin coating will generally suffice because in the spiral construction there will be only one turn between adjacent surfaces in contact and the e.m.f. will be small per turn. The inner termination 7 of the winding is brought radially outwards across one face of the winding over a thin strip of insulating material 8. The termination 9 at the outer end of the winding is folded over diagonally and bent radially outwards to lie contiguous with the other face of the winding.

In Figure 2 several such windings 6 *a*—*e* are mounted by a former 10 of insulating material on a cylindrical core 11 of magnetic material at one end of which a disc-like yoke 12 of magnetic material is affixed. Discs 13 of the insulating material are interposed between each winding and the assembly of windings is mounted between disc-shaped facings 14 and 15 adjacent the yoke and at the opposite end of the coil respectively. The windings are arranged on the core so that their terminations are disposed adjacent one another, and in order to provide for series connection of the windings from end to end of the coil the inner termination 7 of one coil must be joined to the outer termination 9 of the adjacent coil and so on throughout the assembly, leaving the inner and outer terminations at the extreme ends of the assembly for external connections.

The preferred method for making the junctions is to clean the faces of the terminations 7 and 9 which extend beyond the periphery of the winding to remove the superficial oxidised layer. As illustrated in Figure 3, adjacent terminations 7 and 9 are then held in the cleft of a fork 16 which is turned to make a tight roll 17, see Figure 4, after which the fork is

removed. Cold pressure welding is performed by a pair of crimping jaws 18, see Figure 5, having circular anvils 19 in register one with the other which engage with and flatten opposite sides of the roll 17. The jaws 18 are brought together with sufficient pressure to unite the interfaces of the strips disposed between the anvils 19 by cold pressure welding. Preferably the anvils are of such a width that they lie well within the width of the aluminium strips so that the crimping will in effect provide a plurality of pressure-welded junctions which are electrically in parallel. It will, therefore, not be vital if some of the pressure-welded joints are not properly made. In Figure 5 the roll 17 at the right-hand end is ready for welding, the next one to the left is in the act of being welded, while the one on the extreme left has been bent over to lie more flatly against the coil.

Coils may be spirally wound on round or rectangular formers and then assembled permanently on to an electro-magnetic core of corresponding shape with the insulating discs 13, and facings 14 and 15, formed preferably of fibre-glass, interposed between the windings and at opposite ends of the coil respectively. Finally, the coil assembly is impregnated to exclude moisture and render the assembly rigid. Where extreme lightness is a consideration, the coils may be designed to run at a high current rating, and in this connection a silicone fluid or varnish may be used for impregnation. The use of closely wound aluminium strip for the coil, together with suitable impregnation of the coil, provides improved heat transfer from the winding.

A further advantage of using flat aluminium strip as compared with round wire is the saving of space between the turns which enables a more compact coil assembly to be made.

It is found that the use of aluminium conducting strip enables an economy in weight to be achieved even allowing for the different conductivities of aluminium and copper, and the invention may be applied with advantage to aircraft electrical components such as solenoids, contactors and circuit breakers, and it may be applied also in the construction of motor and generator field coils.

What we claim is:—

1. An electro-magnet coil comprising a number of flat spiral windings of uniform aluminium strip mounted side by side on a former with layers of insulating material between them, the consecutive turns of each winding lying directly one upon the other and being electrically insulated from each other by an oxidised surface layer formed on one or both sides of the strip, and electrical junctions formed between the terminations of adjacent windings to provide a series connection of said windings from end to end of the coil.

2. An electro-magnet coil according to claim 1, wherein each electrical junction comprises a flattened roll of the two terminations united at the several interfaces of the roll by cold pressure welds.

3. An electro-magnet coil according to claim 2, wherein the pressure welds are of less width than the strips and are disposed intermediately between the edges of the strips.

For the Applicants:
F. J. CLEVELAND & COMPANY,
Chartered Patent Agents,
29, Southampton Buildings,
Chancery Lane, London, W.C.2.

## PROVISIONAL SPECIFICATION

## Improvements relating to Electro-Magnetic Coils

We, DOWTY EQUIPMENT LIMITED, a British Company, of Arle Court, Cheltenham, in the County of Gloucester, do hereby declare this invention to be described in the following statement:—

This invention relates to coils for electro-magnetic devices and its objects are to provide a construction of less weight than hitherto, and improved heat dissipating properties.

According to the invention, an electrical winding comprises one or more spirally wound coils of aluminium strip whose surfaces are insulated by the formation thereon of thin oxide coatings. Conveniently, the oxide coating may be formed by electrolytic treatment in a bath through which the strip is drawn continuously, and a thin coating will generally suffice because in the spiral construction there will be only one turn between adjacent surface in contact. Where a considerable number of turns are required, several such spiral coils may be arranged side by side on a former or core with facings of insulating material between

the adjacent coils. Preferably all the coils will be wound in the same sense and the inner end portion of each coil will be brought out radially between facings to enable an electrical junction to be made with the outer end portion of an adjacent coil. One method of joining the free end portions of adjacent coils is to abrade the surfaces to remove the oxide film and then roll or turn these end portions together into a tight coil of several turns which are then crimped together under pressure to form a pressure weld. If the crimping jaws are of such a width that they lie well within the width of the aluminium strips, the crimping will in effect provide a plurality of pressure welded junctions which are electrically in parallel so that it will not be vital if some of the welded junctions are not properly made.

The coils may be spirally wound on round or rectangular formers and then assembled permanently on to an electromagnet core of corresponding shape with insulating discs of fibre-glass or other suitable material interposed between the individual coils, after which the junctions are made as previously described. Finally, the coil assembly is impregnated to exclude moisture and render the assembly rigid.

Where extreme lightness is a consideration, the coils may be designed to run at a high current rating, and in this connection a silicone fluid or varnish may be used for impregnation. The use of closely wound aluminium strip for the coil, together with suitable impregnation of the coil, provides improved heat transfer from the winding.

A further advantage of using flat aluminium strip as compared with round wire is the saving of space between the turns which enables a more compact coil assembly to be made.

It is found that the use of aluminium conducting strip enables an economy in weight to be achieved even allowing for the different conductivities of aluminium and copper, and the invention may be applied with advantage to aircraft electrical components such as solenoids, contactors and circuit breakers, and it may be applied also in the construction of motor and generator field coils.

For the Applicants:
F. J. CLEVELAND & COMPANY,
Chartered Patent Agents,
29, Southampton Buildings,
Chancery Lane, London, W.C.2.

Leamington Spa: Printed for Her Majesty's Stationery Office, by the Courier Press.—1954.
Published at The Patent Office, 25, Southampton Buildings, London, W.C.2, from which copies may be obtained.

715,226 COMPLETE SPECIFICATION
1 SHEET

This drawing is a reproduction of the Original on a reduced scale.

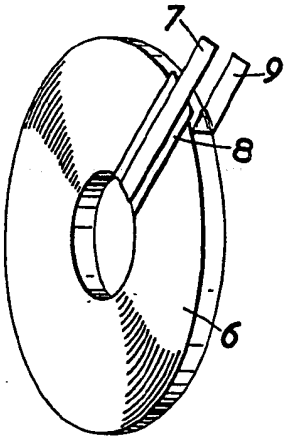


FIG. 1.

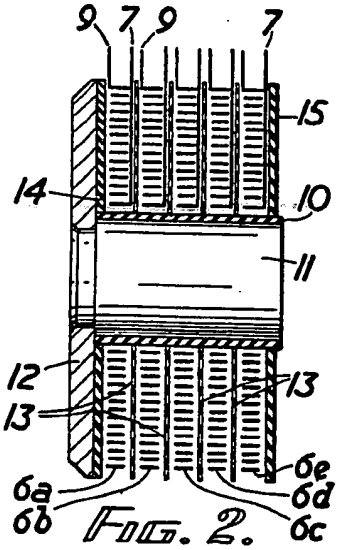


FIG. 2.

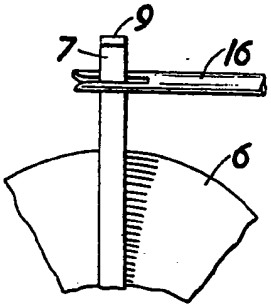


FIG. 3.

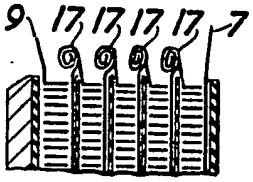


FIG. 4.

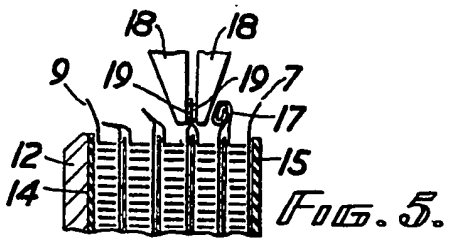


FIG. 5.